

Vehicle Technologies Office (VTO)

Office Overview



U.S. DEPARTMENT OF
ENERGY

Energy Efficiency & Renewable Energy

Michael Berube
Director, VTO

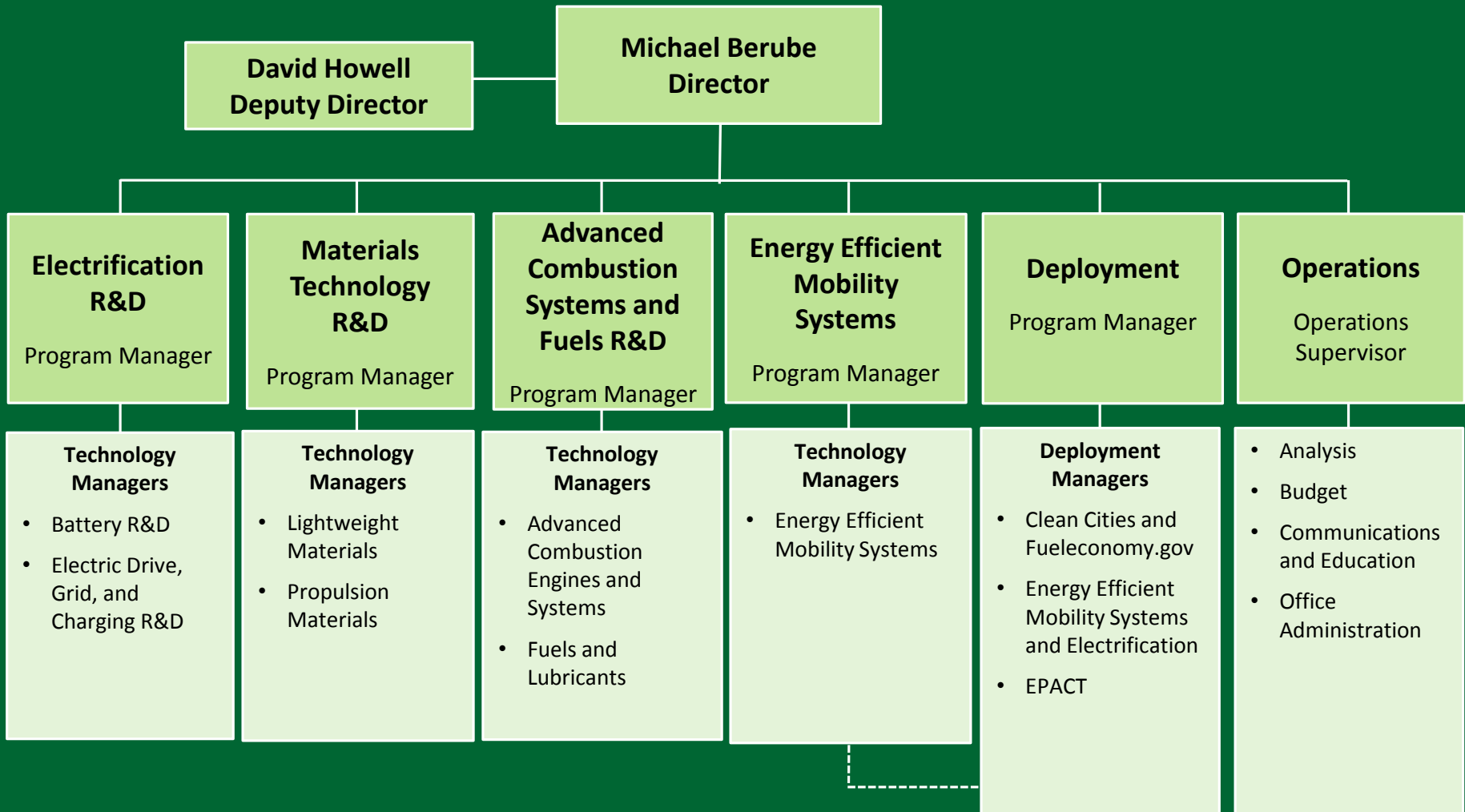
Office of Energy Efficiency and Renewable Energy

Today

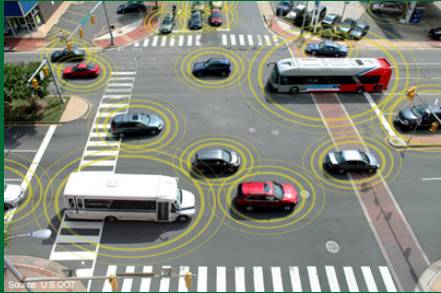
- **What's New**
- **Office Vision and Strategy**
- **Goals and Successes**



VTO Organizational Structure



Why Energy Efficient Mobility Systems (EEMS)?



Connectivity

How can disruption lead to new energy efficiency opportunities?



Ride-sharing

What are the most promising innovation levers?



New Powertrains

What are the risks to energy use and how can we overcome them?



Automation



Car-sharing

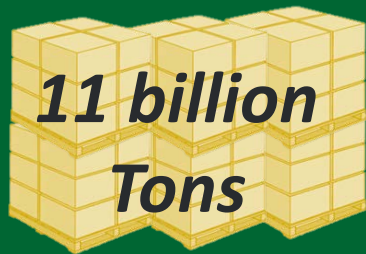


New Modes

VTO Mission

Growing our Economy Requires Transportation, and Transportation Requires Energy

Annually, transport...



**11 billion
Tons**

Goods by



VTO providing **low cost, secure, efficient, and clean** energy technologies to transport people and goods across America



Over 3 Trillion Miles

FY 18 Program Focus and Strategy

Early Stage Research that Advances...



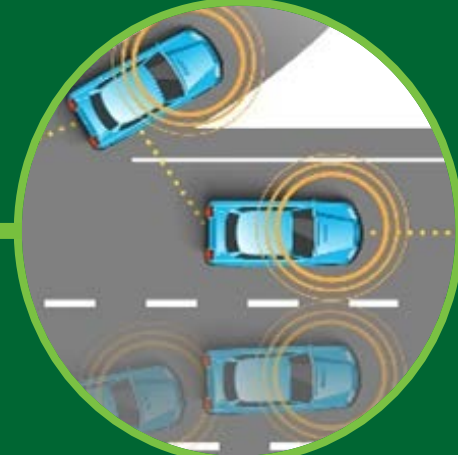
Fuel Diversification

Domestic, Diverse,
Alternative, Clean Fuels



Vehicle Efficiency

Energy Efficient Vehicle
Technologies



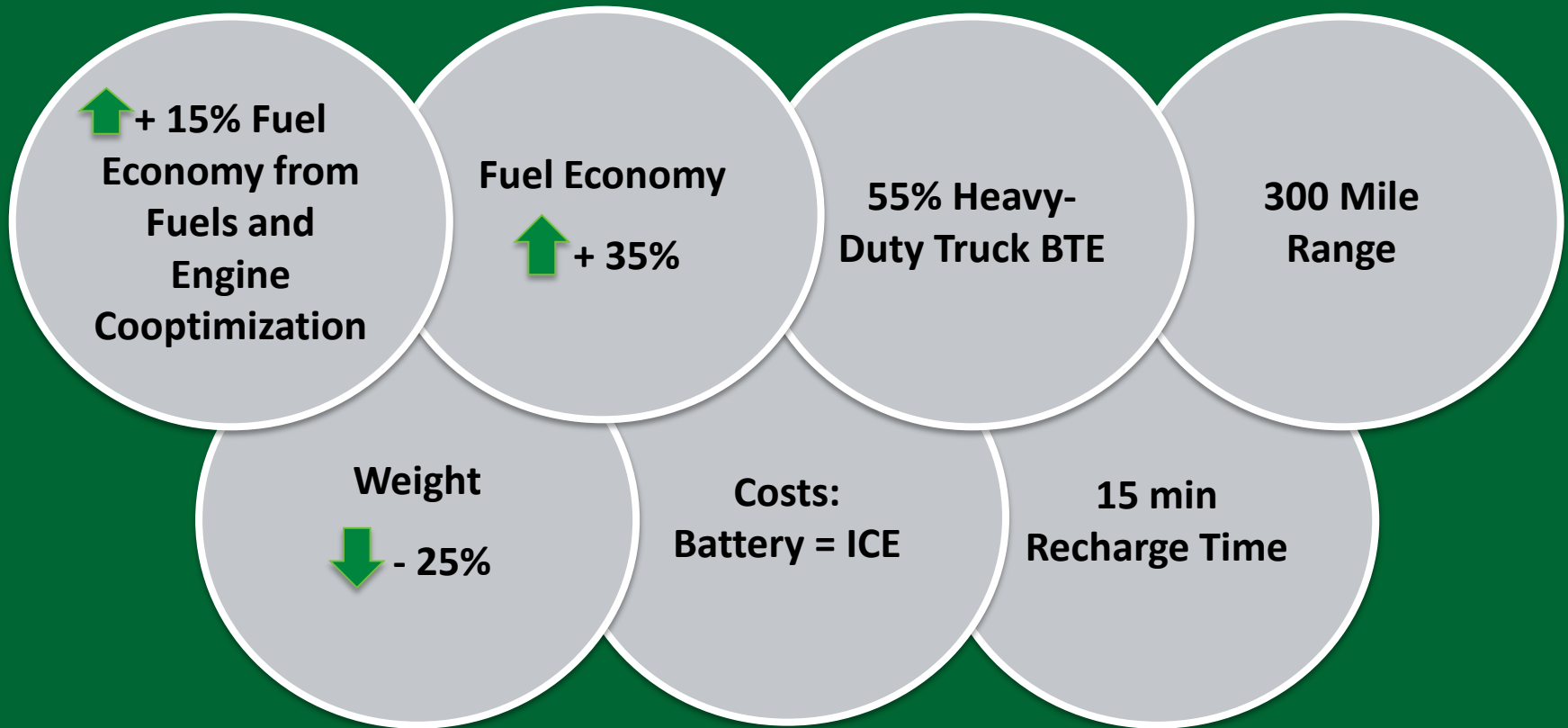
Mobility Systems

Energy Efficient
Transport Systems

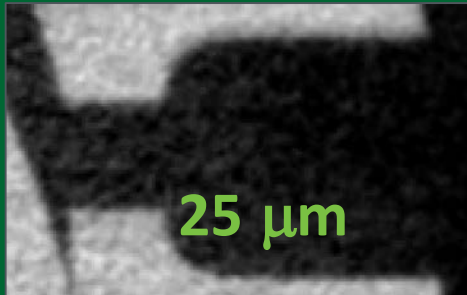
VTO Budget

FY 18 Budget Structure	FY 17 Enacted (\$K)	FY 18 Request (\$K)
Battery and Electrification Technologies	\$140,530	\$36,300
Energy Efficient Mobility Systems	\$16,385	\$12,200
Advanced Engine and Fuel Technologies	\$83,979	\$22,000
Materials Technologies	\$23,565	\$7,500
Outreach	\$37,400	\$2,000
Analysis	<u>\$5,100</u>	<u>\$2,000</u>
TOTAL	\$306,959	\$82,000

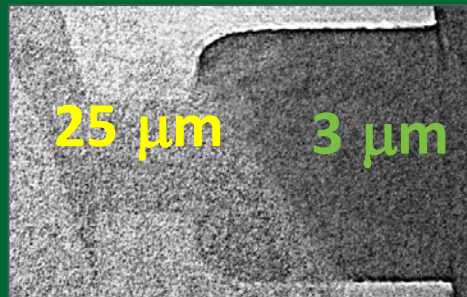
Ambitious Goals



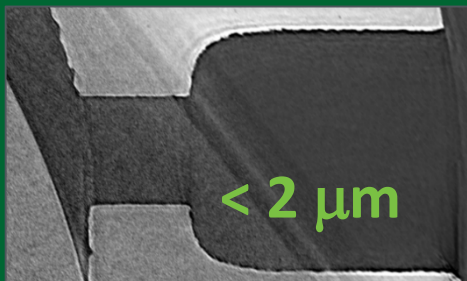
All New Fuel Injector Visualization



Commercial Service



European Synchrotron



Argonne



World-class spatial resolution

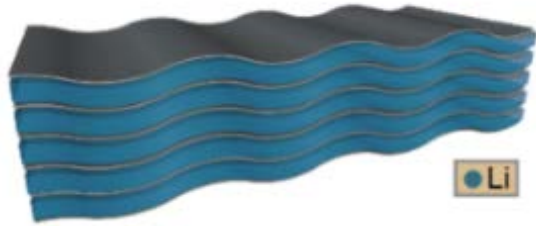
High Precision has been Achieved in
Nozzle Geometry Visualization

Fuel Injector Nozzle Geometry

New Concept to Enable Lithium Metal Anodes

STANFORD
UNIVERSITY

Layered Li-rGO
Composite Film



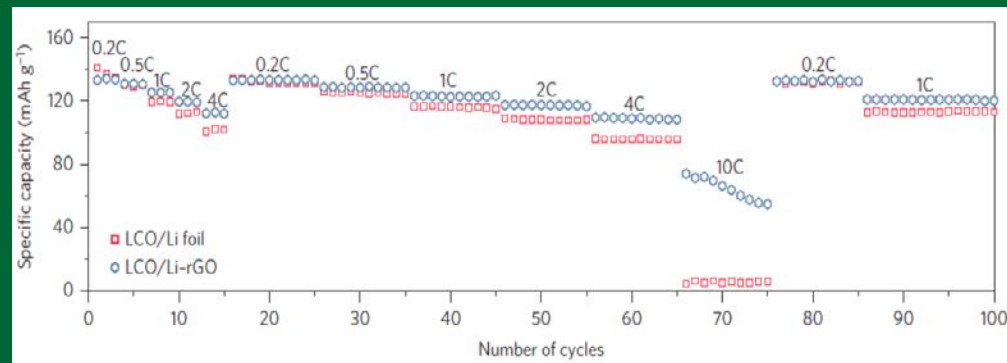
Reduced Graphene Oxide (GO) with Nanoscale
Interlayer Gaps as Stable Host for Li Metal

Novel Structure as Host for Storing
Metallic Lithium

Could lead to



Range
Cost



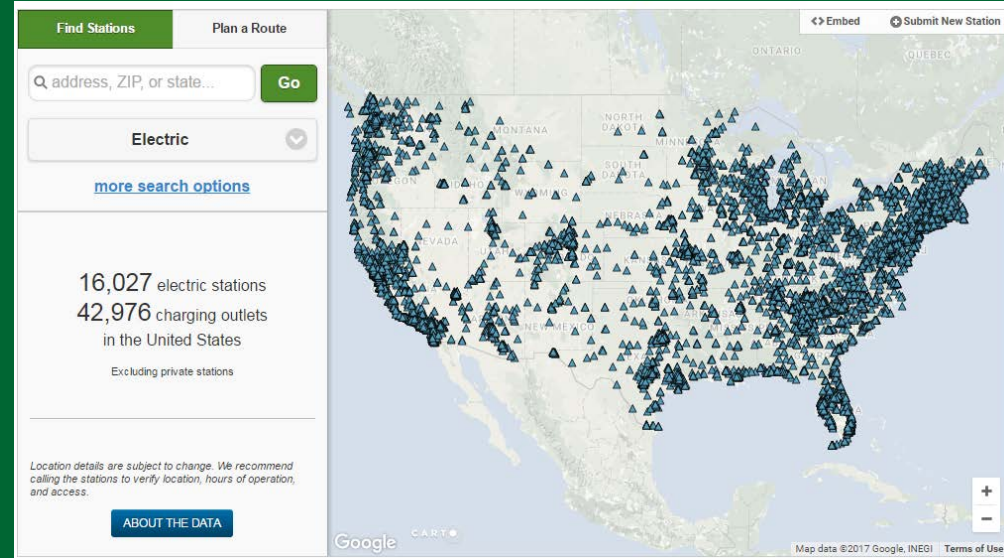
Y. Cui group, *Nature Nanotechnology* (2016)

Cycling of Li-Reduced Graphene Oxide Electrodes

Analysis of Consumer Trips to Understand Charging Needs



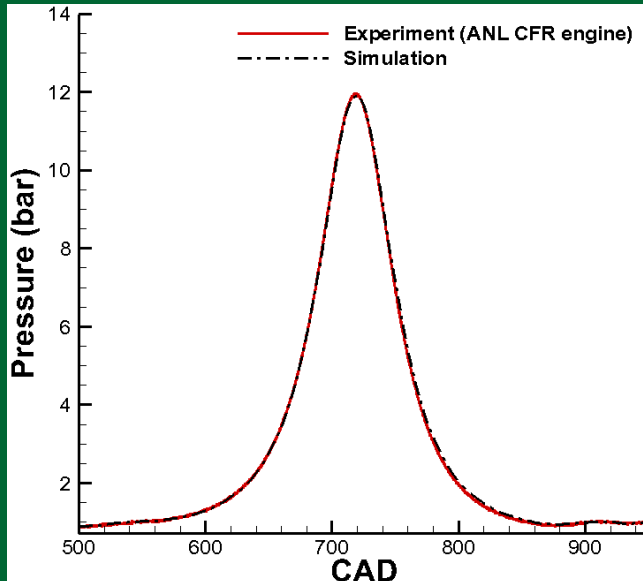
Heat map of Columbus trip destination frequency derived from INRIX data set



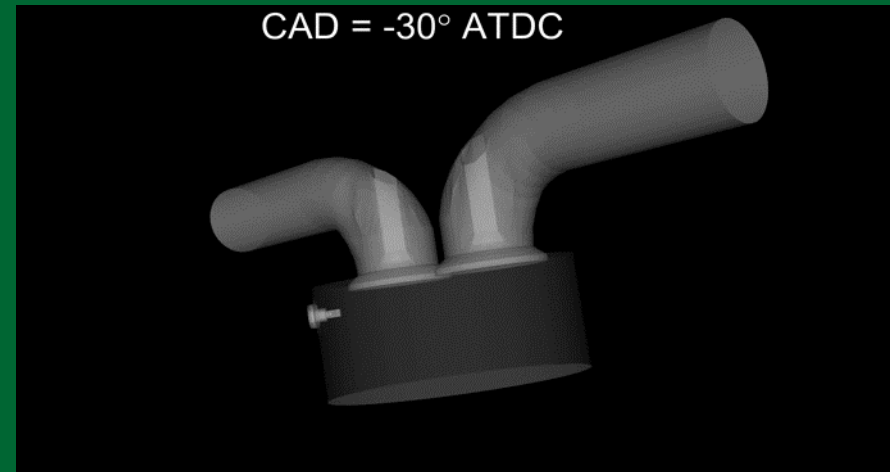
Map of Electric Charging Stations from the Alternative Fuels Data Center



Ability to Derive Knock Computationally



Knock visualization in CFR



Atomic Level Observation Reducing Magnesium Corrosion

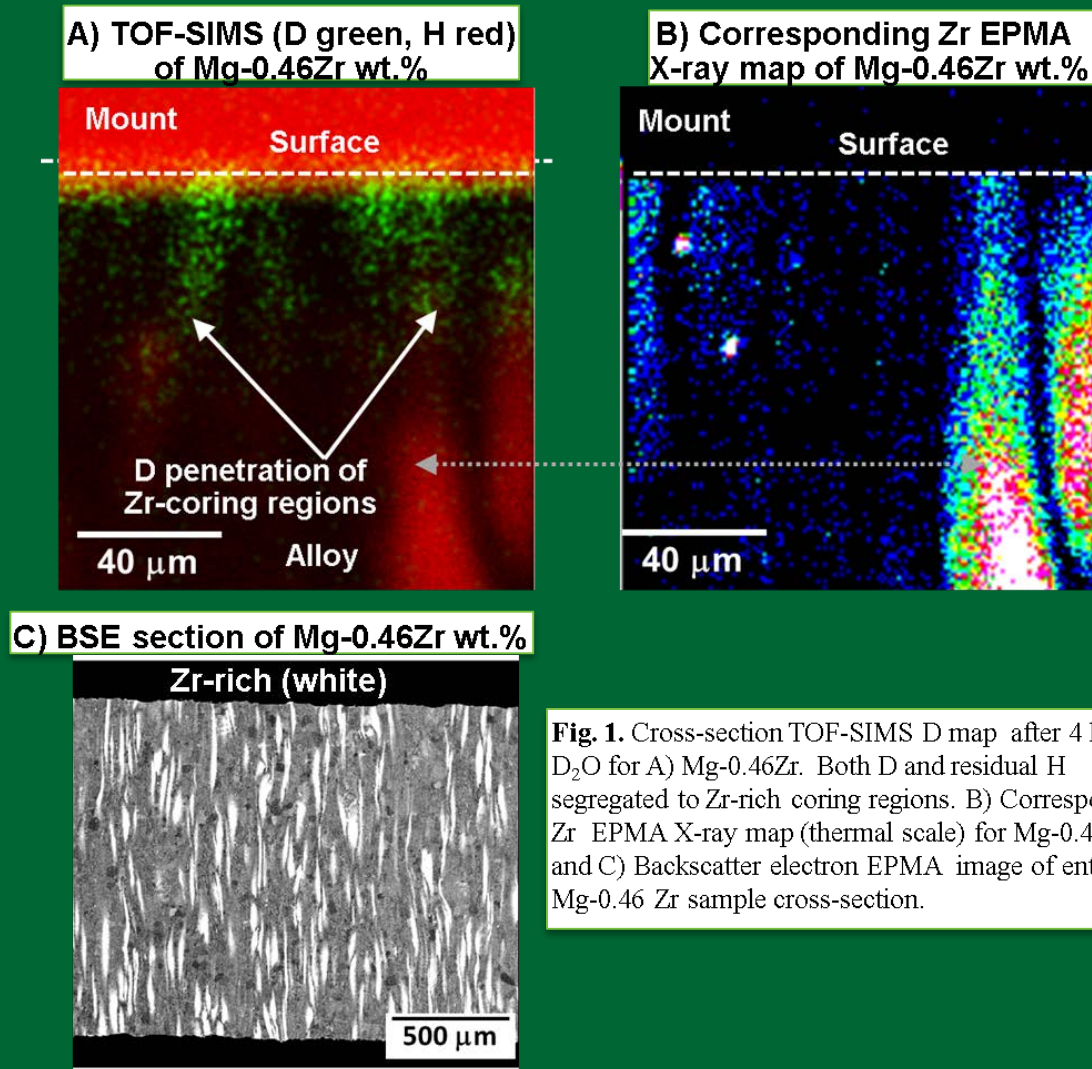


Fig. 1. Cross-section TOF-SIMS D map after 4 h in D_2O for A) Mg-0.46Zr. Both D and residual H segregated to Zr-rich coring regions. B) Corresponding Zr EPMA X-ray map (thermal scale) for Mg-0.46Zr, and C) Backscatter electron EPMA image of entire Mg-0.46 Zr sample cross-section.

New Math Based Models to Control Intersections

Decentralized control

Lemma

For each vehicle i , t_i^f depends only on t_{i-1}^f .

It can be shown^[3] by induction that each vehicle i can solve an optimal control problem in $[t_i^0, t_i^f]$, the solution of which depends only on the solution of the vehicle $i-1$.

Definition

For each vehicle $i \in \mathcal{N}(t)$, we define the cost functional $J_i(u(t))$

$$J_i(u(t)) = \frac{1}{2} \int_{t_i^0}^{t_i^f} u_i^2(t) dt, \quad (6)$$

gives t_i^f , $v_i(t_i^f)$, t_i^0 , $v_i(t_i^0)$.

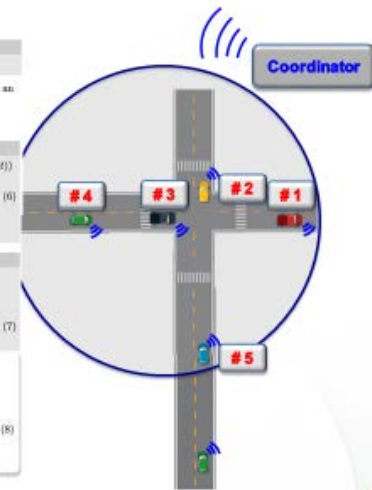
Definition

For each vehicle $i \in \mathcal{N}(t)$, we define the set $\mathcal{M}_i \subset \mathcal{U}_i$

$\mathcal{M}_i \triangleq \{u_i \in \mathcal{U}_i | \min J_i(u(t)), \text{ subject to : vehicle dynamics (1) and state/control bounds (2)}\}, \quad (7)$

$$\min_{u_i \in \mathcal{M}_i} \sum_{n=2}^{N(t)} (u_{i(n-1)}^2(t) - u_{i(n)}^2(t)) \quad (8)$$

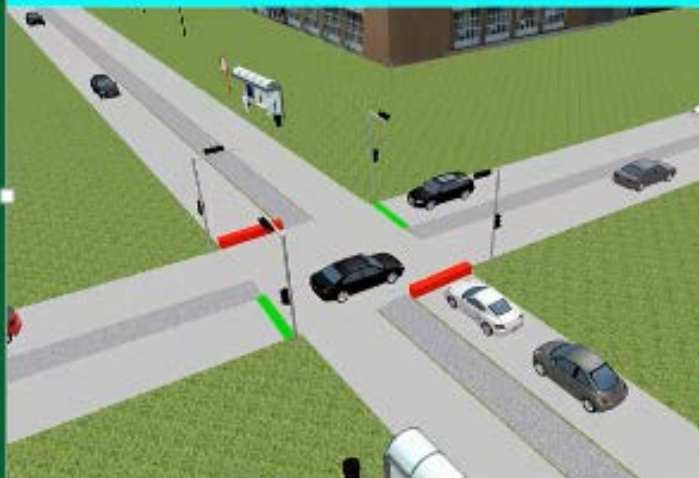
Subject to : $u_i \in \mathcal{M}_i, \forall i \in \mathcal{N}(t)$,
rear-end collision - (3), and
lateral collision - (5).



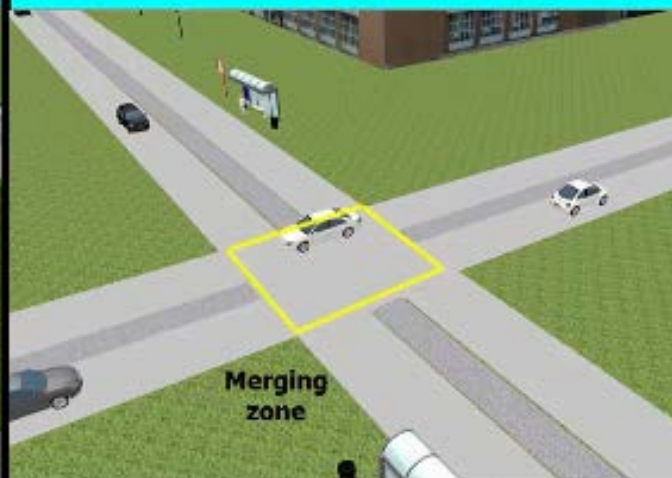
OAK RIDGE
National Laboratory

Intersection Control

Baseline case



Decentralized optimal control

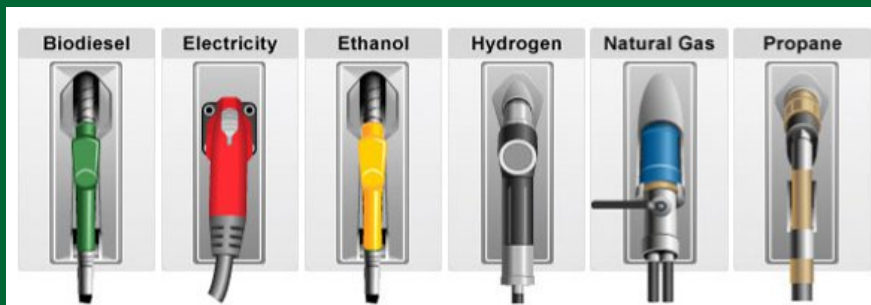
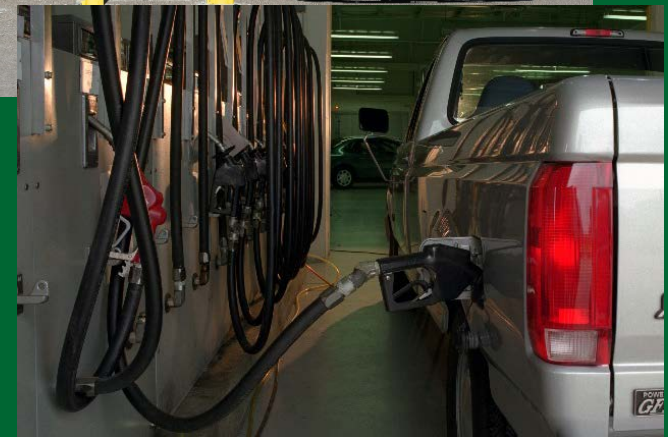
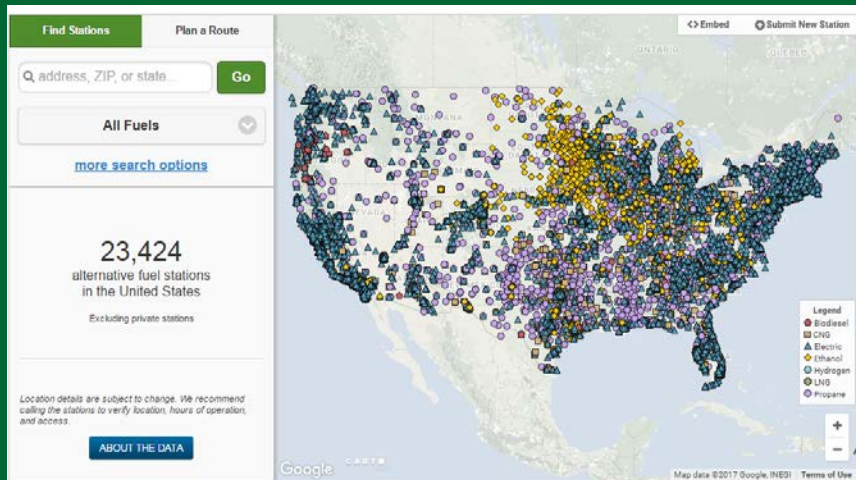
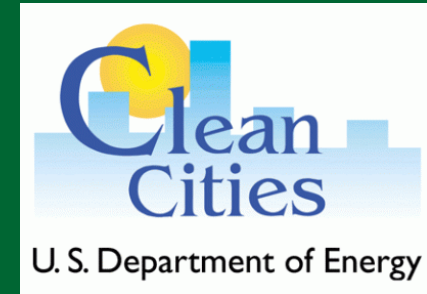


Vehicle Technologies in Use




EEMS Living Labs

www.fueleconomy.gov
the official U.S. government source for fuel economy information



Keys for a Successful VTO



**Portfolio
Approach**

Partnerships

**Ambitious
Targets**

Great Team

Thank You